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Evaluation between Soft Tissue Chin Thickness and Mandibular Divergence Pattern

Dr. Kiran Gode, Private Practice, Mumbai

Dr. Ketan Vakil, Hod And Professor, S.M.B.T Dental College And Hospital, Sangamner

Dr. Jeegar Vakil, Associate Professor, S.M.B.T Dental College And Hospital, Sangamner

Dr. Snehal Pathak*, Assistant Professor, YCMM And RDF Dental College, Ahmednagar

Dr. Rajlaxmi Rai, Assistant Professor, YCMM And RDF Dental College, Ahmednagar

Dr. Nimish Wajekar, Private Practice, Mumbai.

Corresponding Author: Dr. Snehal Pathak, Assistant Professor, YCMM And RDF Dental College, Ahmednagar

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Abstract

Objectives: To evaluate the association between the soft tissues chin [STC] thickness and mandibular divergence pattern.

Methods: 200 pre-treatment lateral cephalograms of adult subjects were taken. Patients were stratified into four groups based on the divergence pattern defined by the mandibular plane to cranial base angle (MP/SN; average = $32^0 + 5^0$). The angle included Palatal Plane to Mandibular Plane (PP/MP), Palatal Plane to Horizontal (PP/H), Mandibular Plane to Horizontal (MP/H), and Mandibular Plane to Anterior cranial base (MP/SN). The sagittal relationship between the jaws was assessed by the ANB angle. The STC thickness was measured at three different levels-

(1) Pog-Pog'; (2) Gn-Gn'; and (3) Me-Me'. The three distances were measured using NEMOTEC Software.

Results: All Skeletal cephalometrics had the highest measurements in the hypodivergent group H and gradually decreased across the groups, the lowest being in the hyperdivergent group L. All skeletal cephalometric measurements (PP/MP, PP/H, MP/H, MP/SN) were statistically significant across four groups stratified based on MP/SN angle using Anova F Test ($p < 0.05$). The ANB angle was not statistically significant among the four groups. (P value = 0.106).

Conclusion: Soft tissue thickness measurements were smaller in adult patients with vertical hyperdivergent pattern compared with clinically normal and hypodivergent patterns. Subjects with hyperdivergent mandible exhibited a statistically significantly thinner STC at Gn' and Me' in comparison with subjects having a hypodivergent pattern. All STC measurements were greater in men than in women.

Keywords: Soft tissue chin(STC), Nemotec Software, Hyperdivergent, Hypodivergent

Introduction

The field of orthodontics has experienced a paradigm shift to focus more on esthetics, with specific emphasis on soft tissues around the mouth. Evaluation of facial esthetics is considered to be subjective, because balance and harmony of facial components do not necessarily mean an attractive face.[1] Only humans have a pronounced chin and the position of the chin is certainly important feature for facial harmony.[2] Final facial contours are determined by the soft tissues which influences the esthetics. In orthodontic treatment, a harmonious soft-tissue profile can be difficult to achieve; the thickness of the soft tissues can vary greatly and changes with growth and treatment can be difficult to predict.[3] There is great individual variation in period, magnitude, and pattern of growth in different parts of the face, and thus studying these variables is fundamental for orthodontic treatment.[3]

The vertical dimension influences orthodontic diagnosis and treatment planning in adult patients and it has been seen that minimal attention is dedicated to the role of soft tissue characteristics in establishing optimal diagnosis and treatment plan. Two commonly used measurements (inclination of the mandible to the anterior cranial base or to the maxilla and percentage of lower to the total facial height) have emerged to aid in determining the vertical facial type in relation to underlying skeletal features.[4]

Today, the most favoured approach for correction of skeletal chin deformity is the horizontal osteotomy of the inferior border of the mandible, commonly termed genioplasty. Genioplasty allows 3-dimensional control of chin position, resulting in significant improvements in facial esthetics whether performed separately or combined with other orthognathic surgical procedures. Advancement genioplasty to correct a receding chin is probably the most common procedure.[5]

Genioplasty, indicated to restore adequate shape and projection of the chin, has been performed to enhance soft tissue contours related to disproportion between soft and hard tissue and has produced stable long-term postsurgical changes. High correspondence of soft tissue changes at the chin level has been reported after advancement genioplasty, resulting in a ratio of bony tissue to soft tissue ranging from 1:0.75 to 1:0.92.[4]

Therefore, the aim of this study was to compare soft tissue chin thickness in adult patients with various mandibular divergence patterns and the difference in STC thickness between men and women.

Methodology

200 pre-treatment lateral cephalograms of adult subjects (above 18 years) were taken. The lateral cephalometric radiographs were taken using the same digital cephalostat in a standardized method and in a natural head position.

Inclusion Criteria:1) Patients above 18 years of age who reported in the department for orthodontic treatment. 2) Only those lateral cephalograms were selected which were taken at rest with no strain, having well defined identifiable chin structure on radiograph. 3) All cephalograms which were obtained were taken from same cephalostat. *Exclusion Criteria*: 1) Patients who had history of previous orthodontic and /or orthognathic treatment. 2) Presence of craniofacial anomaly or of a non-continuous soft tissue contour at the level of the chin indicating a chin strain presence.

All the 200 scanned images were saved in a folder with the help of Nemotec cephalometric software. All the scanned cephalograms were traced and all angular and linear measurements were performed by using this software. Angular measurements were computed to determine the vertical position of the maxilla and mandible in relation to the anterior cranial base, to true horizontal, and to each other. The angle included palatal plane to mandibular plane (PP/MP), palatal plane to horizontal (PP/H), mandibular plane to horizontal (MP/H), and mandibular plane to anterior cranial base (MP/SN). The angular measurement of MP/SN and ANB were derived by Jarabak and Bondi analysis. Similarly, PP/MP and PP/H were derived with help of McGan analysis and PP/H was derived by using Bejarano-DIOC analysis. The sagittal relationship between the jaws was assessed by the ANB angle.

Patients were stratified into four groups based on the divergence pattern defined by the mandibular plane to cranial base angle (MP/SN; average = $32^0 + 5^0$).

Group1 - Low (L) = MP/SN < 27^0 -Total 64 samples were taken (49 Male and 15 Female).

Group2 - Medium-Low (ML) = 27^0 < MP/SN < 32^0 - Total 55 samples were taken (24 Male and 31 Female).

Group3 - Medium-High (MH) = 32^0 < MP/SN < 37^0 - Total 41 samples were taken (18 Male, 23 Female).

Group4 - High (H) = MP/SN > 37^0 -Total 40 samples were taken (9 Male 31 Female).

The STC thickness was measured at three different levels (1) Pog-Pog' {length between bony pogonion (Pog) and its horizontal projection (Pog') over the vertical passing through soft tissue pogonion}; (2) Gn-Gn' {distance between bony gnathion (Gn) and soft tissue gnathion (Gn')}; and (3) Me-Me' {distance between bony menton (Me) and its vertical projection (Me') on the horizontal passing through soft tissue menton}. Linear measurement between hard tissue Pog to soft tissue Pog' and hard tissue Me to soft tissue Me' were measured with the help of Soft Tissue Cephalometric Analysis. The distance between hard tissue Gn to soft tissue Gn' was measured manually with the help of NEMOTEC software measurement scale. To determine the intra-observer reliability, a single investigator repeated all angular and linear cephalometric measurements on 20 randomly selected cephalographs.

Results

On comparison among total samples, mean value of age was 23.09 + 4.12 years and the range was between 18.0 – 34.0 years. The mean age for males was 23.71 + 4.22 years and the range was between 18.0 – 34.0 years. For females mean value of age was 22.48 + 3.94 years and the range was between 18.0 – 34.0 years. Age was not statistically, significantly different for men (p = 0.456) or women (p = 0.275) across the four groups stratified based on MP/SN angle.

All groups had corresponding vertical skeletal cephalometric measurements (PP/H, MP/H, MP/SN, PP/MP) compatible with the degree of mandibular divergence initially stratified on MP/SN. On comparison of mean cephalometrics and soft tissue at the chin measurements in the groups stratified on MP/SN the values were as follows.

Group 1 {Low MP/SN ≤ 27^0} the mean values of cephalometric measurements were [PP/MP = 16.26^0, PP/H = -1.94^0, MP/H = 16.85^0, MP/SN = 22.68^0] and ANB angle was 1.27^0 and the soft tissue chin measurements were [Pog-Pog' = 11.3 mm, Gn-Gn'= 8.14 mm, Me-Me'= 7.47 mm].

Group 2 {Medium-Low (ML) = 27^0 < MP/SN < 32^0} the mean values of cephalometric measurements were [PP/MP = 19.93^0, PP/H = -0.47^0, MP/H = 19.71^0, MP/SN = 29.53^0] and ANB angle was 2.69^0 and the soft tissue chin measurements were [Pog-Pog' = 11.05 mm, Gn-Gn'= 7.03 mm, Me-Me' = 6.69 mm].

Group 3 {Medium-High (MH) = 32^0 < MP/SN < 37^0} the mean values of cephalometric measurements were [PP/MP = 21.93^0, PP/H = 0.33^0, MP/H = 21.87^0, MP/SN = 33.54^0] and ANB angle was 1.69^0 and the soft tissue chin measurements were [Pog-Pog' = 10.39 mm, Gn-Gn'= 6.3 mm, Me-Me' = 6.78 mm].

Group 4 {High (H) = MP/SN > 37^0} the mean values of cephalometric measurements were [PP/MP = 28.07^0, PP/H = 0.44^0, MP/H = 29.82^0, MP/SN = 40.65^0] and ANB angle was 2.72^0 and the soft tissue chin measurements were [Pog-Pog' = 10.14 mm, Gn-Gn'= 6.10 mm, Me-Me' = 6.59 mm].

Table1. shows that all Skeletal cephalometrics had the highest measurements in the hypodivergent group H and gradually decreased across the groups, the lowest being in

the hyperdivergent group L. All skeletal cephalometric measurements (PP/MP, PP/H, MP/H, MP/SN) were statistically significant across four groups stratified based on MP/SN angle using ANOVA F Test ($p < 0.05$). The ANB angle was not statistically significant among the four groups. (p value = 0.106).

On individual intergroup comparison using Tukey's post hoc test, these measurements were statistically highly significant among the groups L-MH, L-H, ML-H, MH-H ($p < 0.001$). Group PP/H, L-MH and L-H were statistically significant ($p < 0.05$**)** and L-ML, ML-MH, ML-H, MH-H were statistically not significant ($p > 0.05$).

All STC thicknesses had the highest measurements in the hypodivergent group L and gradually decreased across the groups, the lowest being in the hyperdivergent group H.

At the level of Pog, the distance Pog-Pog' (group L = 11.3 + 1.68 mm; group ML = 11.05 + 1.64 mm; group MH = 10.39 + 2.00 mm; group H = 10.14 + 2.58 mm) was statistically not significant between groups L-ML, L-MH, L-H, ML-MH, ML-H, MH-H (p = 0.051).

At the level of Me, the distance Me-Me' (group L = 7.47 + 1.87 mm; group ML = 6.97 + 1.13 mm; group MH = 6.78 + 1.67 mm; group H = 6.59 + 2.55 mm) was statistically not significant among all groups except L-H group (p = 0.041).

At the level of Gn, the distance Gn-Gn' (group L = 8.14 + 1.87 mm; group ML = 6.00 + 1.87 mm; group MH = 6.3 + 1.46 mm; group H = 6.10 + 2.41 mm) was statistically significant in all groups except ML-H (p = 0.929)

	Skeletal Cephalometrics Measurement					Soft Tissue Measurement		
	PP/MP	**PP/H**	**MP/H**	**MP/SN**	**ANB**	**Pog-Pog'**	**Gn-Gn'**	**Me-Me'**
LOW MP/SN ≤27^0	**16.26** **(4.16)**	**-1.94** **(3.10)**	**16.85** **(4.76)**	**22.68** **(3.00)**	**1.27** **(3.23)**	**11.3** **(1.68)**	**8.14** **(1.87)**	**7.47** **(1.87)**
MEDIUM – LOW 27^0< MP/SN ≤32^0	**19.93** **(4.30)**	**-0.47** **(2.93)**	**19.71** **(4.56)**	**29.53** **(1.30)**	**2.69** **(3.22)**	**11.05** **(1.64)**	**6.00** **(1.86)**	**6.97** **(1.13)**
MEDIUM – HIGH 32^0 < MP/SN <37^0	**21.93** **(4.17)**	**0.33** **(4.30)**	**21.87** **(3.63)**	**33.54** **(1.00)**	**1.69** **(3.50)**	**10.39** **(2.00)**	**6.3** **(1.46)**	**6.78** **(1.67)**
HIGH MP/SN ≤ 37^0	**28.07** **(5.37)**	**0.44** **(3.54)**	**29.82** **(4.65)**	**40.65** **(4.12)**	**2.72** **(4.94)**	**10.14** **(2.58)**	**6.10** **(2.41)**	**6.59** **(2.55)**
ANOVA (*p* value)	**0.000****	**0.001***	**0.000****	**0.000****	**0.106**	**0.051**	**0.001***	**0.088**
L – ML	**0.000****	**0.094**	**0.004***	**0.000****	**0.162**	**0.261**	**0.007***	**0.149**
L – MH	**0.000****	**0.006***	**0.000****	**0.000****	**0.944**	**0.780**	**0.043***	**0.982**

L –H	**0.000****	**0.004***	**0.000****	**0.000****	**0.212**	**0.529**	**0.002***	**0.041***
ML –MH	**0.137**	**0.660**	**0.095**	**0.000****	**0.555**	**0.891**	**0.001***	**0.112**
ML – H	**0.000****	**0.566**	**0.000****	**0.000****	**1.000**	**0.058**	**0.929**	**0.732**
MH – H	**0.000****	**0.999**	**0.000****	**0.000****	**0.588**	**0.163**	**0.000****	**0.671**

Table 1: *Comparison of mean cephalometric and soft tissue at the chin in the groups stratified on MP/SN.*

Comparison of mean soft tissue measurements at the chin in the groups stratified on MP/SN for Male PopulationThe following values were recorded as in Table2. At the level of Pog, the distance Pog-Pog' (group L = 11.90 + 1.64 mm; group ML = 11.75 + 1.71 mm; group MH = 11.35 + 1.91 mm; group H = 10.90 + 2.45 mm) was statistically not significant among groups Low, Medium Low, Medium High, High using ANOVA F test (p = 0.078). On individual intergroup comparison using Tukey's post hoc test, these measurements were statistically not significant among the groups L-ML, L-MH, L-H, ML-MH, ML-H, MH-H (p >0.05)At the level of Gn, the distance Gn-Gn' (group L = 8.99 + 1.80 mm; group ML = 8.69 + 1.55 mm; group MH = 8.45 + 1.62 mm; group H = 7.18 + 2.26 mm) was statistically significant among all groups Low, Medium Low, Medium High, High using ANOVA F test (p = 0.021). On individual intergroup comparison using Tukey's post hoc test, these measurements were statistically significantamong the groups L-MH, L-H, ML-MH, ML-H, MH-H (p < 0.05) except for group L-ML was statistically not significant (p = 0.478).At the level of Me, the distance Me-Me' (group L = 7.89 + 1.77 mm; group ML = 7.81 + 1.11 mm; group MH = 7.77 + 2.08 mm; group H = 6.69 + 2.12 mm) was statistically not significant among all groups Low, Medium Low, Medium High, High using ANOVA F test (p = 0.095). On individual intergroup comparison using Tukey's post hoc test, these measurements were statistically not significant among all the groups L-ML, L-MH, L-H, ML-MH, ML-H, MH-H (p > 0.05).

Table 2- Comparison of mean soft tissue measurements at the chin in the groups stratified on MP/SN for male Population

MALES	Soft Tissue Measurement		
	Pog-Pog' MEAN (S.D)	**Gn-Gn' MEAN (S.D)**	**Me-Me'**
LOW MP/SN $\leq 27^0$	**11.90 (1.64)**	**8.99 (1.80)**	**7.89 (1.77)**
MEDIUM – LOW $27^0 <$ MP/SN $\leq 32^0$	**11.75 (1.71)**	**8.69 (1.55)**	**7.81 (1.11)**
MEDIUM – HIGH $32^0 <$ MP/SN $< 37^0$	**11.35 (1.91)**	**8.45 (1.62)**	**7.77(2.08)**
HIGH MP/SN $\leq 37^0$	**10.90 (2.45)**	**7.18 (2.26)**	**6.69 (2.12)**
ANOVA (*p* value)	**0.078**	**0.021***	**0.095**
L - ML	**0.997**	**0.478**	**0.836**
L - MH	**0.995**	**0.047***	**0.970**
L –H	**0.051**	**0.001***	**0.149**
ML –MH	**0.999**	**0.049***	**0.711**
ML - H	**0.092**	**0.021***	**0.064**
MH - H	**0.104**	**0.036***	**0.386**

Comparison of mean soft tissue measurements at the chin in the groups stratified on MP/SN for Female Population

At the level of Pog, the distance Pog-Pog' (group L = 10.88 ± 1.87 mm; group ML = 10.71 ± 1.34 mm; group MH = 10.16 ± 2.01 mm; group H = 10.10 ± 2.24 mm) was statistically not significant among groups Low, Medium Low, Medium High, High using ANOVA F test (*p* = 0.100).

On individual intergroup comparison *(Table 3)* using Tukey's post hoc test, these measurements were statistically not significant among the groups L-ML, L-MH, L-H, ML-MH, ML-H, MH-H ($p > 0.05$)

At the level of Gn, the distance Gn-Gn' (group L = 7.92 $\pm$ 1.66 mm; group ML = 6.85 $\pm$ 1.39 mm; group MH = 6.29 $\pm$ 1.25 mm; group H = 5.70 $\pm$ 1.95 mm) was statistically highly significant among all groups Low, Medium Low, Medium High, High using ANOVA F test ($p = 0.000$). On individual intergroup comparison using Tukey's post hoc test, these measurements were statistically significant among the groups L-MH, ML-MH, ML-H, MH-H ($p < 0.05$) except for group L-ML was statistically not significant ($p = 0.0921$) and group LH was statistically highly significant ($p < 0.001$).

At the level of Me, the distance Me-Me' (group L = 7.07 $\pm$ 2.19 mm; group ML = 6.52 $\pm$ 1.04 mm; group MH = 6.47 $\pm$ 1.28 mm; group H = 6.39 $\pm$ 2.46 mm) was statistically not significant among all groups Low, Medium Low, Medium High, High using ANOVA F test ($p = 0.095$). On individual intergroup comparison using Tukey's post hoc test, these measurements were statistically not significant among all the groups L-ML, L-MH, L-H, ML-MH, ML-H, MH-H ($p > 0.05$).

FEMALE	Soft Tissue Measurement		
	Pog-Pog MEAN (S.D)	Gn-Gn MEAN (S.D)	Me-Me MEAN (S.D)
LOW MP/SN $\leq 27^0$	10.88(1.87)	7.92 (1.66)	7.07 (2.19)
MEDIUM – LOW $27^0 <$ MP/SN $\leq 32^0$	10.71(1.34)	6.85 (1.39)	6.52 (1.04)
MEDIUM –HIGH $32^0 <$ MP/SN $<37^0$	10.16 (2.01)	6.29 (1.25)	6.47 (1.28)
HIGH MP/SN $\leq 37^0$	10.10 (2.24)	5.70 (1.95)	6.39 (2.46)
ANOVA (*p* value)	0.100	0.000**	0.153
L – ML	0.284	0.0921	0.545
L – MH	0.756	0.039*	0.960
L –H	1.000	<0.001**	0.781
ML –MH	0.828	0.004*	0.155
ML – H	0.104	0.001*	0.963
MH – H	0.582	0.037*	0.343

Table 3: *Comparison of mean soft tissue measurements at the chin in the groups stratified on MP/SN for Female Population*

Discussion

The main purpose of this study was the association between mandibular vertical divergence and STC thickness and the difference in STC thickness between men and women. The STC thickness apparently adapts to severe hyperdivergence, presumably through increased stretching of the STC in children with progressive increase in facial divergence. [4,6]

In this study, we found that STC thickness was statistically significant at Gn but not significant in Me and Pog which suggests the presence of a differential extension between hard and soft tissues during growth. The reason that might account for the lack of significance at Me rather than the statistical significance observed at Gn between group H and each of the medium groups ML and MH was that, STC was thicker at Me, probably rendering it more stretchable than at Gn. Group H was statistically significantly different from only group L at Me emphasizes the fact that, extreme hyperdivergence was distinct from the other groups both in soft tissue thickness and in response to vertical growth. [4,7] The findings were further interpreted in the context of growth and gender differences.

On comparison of mean cephalometrics and soft tissue at the chin measurments in the groups stratified on MP/SN. In Group High (H) = MP/SN > 37^0 the mean values of cephalometric measurements were [PP/MP = 28.07^0, PP/H = 0.44^0, MP/H = 29.82^0, MP/SN = 40.65^0] and ANB angle was 2.72^0 and the soft tissue chin measurements were [Pog-Pog' = 10.14 mm, Gn-Gn'= 6.10 mm, Me-Me' = 6.59 mm]. In group Low MP/SN $\leq 27^0$ the mean values of cephalometric measurements were [PP/MP = 16.26^0, PP/H = -1.94^0, MP/H = 16.85^0, MP/SN = 22.68^0] and ANB angle was 1.27^0 and the soft tissue chin measurements were [Pog-Pog' = 11.3 mm, Gn-Gn'= 8.14 mm, Me-Me'= 7.47 mm].

All skeletal cephalometric readings had the highest measurements in the hypodivergent group and the lowest being in the hyperdivergent group, which suggest that there was gradual decrease in the readings from hypodivergent group to hyperdivergent group. Soft tissue thickness measurements were smaller in adult patients with vertical hyperdivergent pattern compared with adult patients with clinically normal and hypodivergent patterns. Previous studies by Alcalde RE[9] found that, significant differences in soft tissue cephalometric standards in the Japanese sample when compared with the white norms. Few studies had been carried out by Takia AA[1], to define the cephalometric soft tissue norms of Persian adults, and to determine if there were any differences between Persians and whites. In their study, they used Holdaway analysis because it represents the soft tissue more in detail with simplicity and it was widely used for evaluation of soft tissue profiles.

The clinical significance of this study was that more advancement genioplasty to achieve better chin projection may be needed in patients with severe hyperdivergence because the mandible has grown more vertically at the expense of its anterior projection; this premise would support the high rate of genioplasty which was observed in patients with hyperdivergent long faces. Although the findings addresses the aim of study to evaluate STC thickness as one contributing factor to chin extension, further investigation is required to assess the presence and contribution of other variables in defining the overall chin and facial esthetics.

Conclusion

Careful interpretation of the findings led us to the following conclusions:

1. Cephalometric findings suggest that gender has an impact on soft tissue measurements as STC measurement were greater in men as compared to female.
2. All skeletal cephalometrics had the highest measurements in the hypodivergent group H and gradually decreased across the groups, the lowest being in the hyperdivergent group L.
3. All STC thickness had the highest measurements in the hypodivergent group L and gradually decreased across the groups, the lowest being in the hyperdivergent group H.
4. Cephalometric measurements of patient's with hypodivergent mandible exhibited a statistically significant thicker STC at Gn and Me in comparison with patients having a hyperdivergent pattern.
5. The findings suggest that STC thickness in hyperdivergent pattern should be considered differently at its most anterior point (Pog) relative to its inferior landmarks (Gn and Me), since soft tissue thickness was statistically significantly different at Gn and Me but not at Pog.

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